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Signed Andrew Gersey

Dated 25 September 2000

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The Patent Office
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1. Your reference — P24532/ACO/MVE/JAL 06SEP99 E474510-1 D02984 P01/7700 0.00 - 9920935.5

2. Patent application number *(The Patent Office will fill in this part)* — **9920935.5**

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

e2 TECH Limited
Stoneywood Park North
Dyce
ABERDEEN
AB21 7EA

Patents ADP number *(if you know it)* 07734395001

If the applicant is a corporate body, give the country/state of its incorporation — United Kingdom

4. Title of the invention — "Apparatus for and a Method of Anchoring a First Conduit to a Second Conduit"

5. Name of your agent *(if you have one)* — Murgitroyd & Company

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

373 Scotland Street
Glasgow
G5 8QA

Patents ADP number *(if you know it)* 1198013

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(If you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicants is a corporate body.
See note (d))

Yes

"Apparatus for and Method of Anchoring a First Conduit to a Second Conduit"

The present invention relates to an apparatus for and a method of anchoring a first conduit to a second conduit, the apparatus and method particularly, but not exclusively, using an inflatable device to provide an anchor.

A borehole is conventionally drilled during the recovery of hydrocarbons from a well, the borehole typically being lined with a casing. Casings are installed to prevent the formation around the borehole from collapsing. In addition, casings prevent unwanted fluids from the surrounding formation from flowing into the borehole, and similarly, prevents fluids from within the borehole escaping into the surrounding formation.

Boreholes are conventionally drilled and cased in a cascaded manner; that is, casing of the borehole begins at the top of the well with a relatively large outer diameter casing. Subsequent casing of a smaller diameter is passed through the inner diameter of the casing above, and thus the outer diameter of the

drill pipe, rods, coiled tubing, a wireline or the like).

Lengths of expandable casing are coupled together (typically by threaded couplings) to produce a casing string. The casing string is inserted into the borehole in an unexpanded state and is subsequently expanded using the expander device, typically using a substantial force to facilitate the expansion process. However, the unexpanded casing string requires to be anchored either at, or near, an upper end or a lower end thereof during the expansion process to prevent undue movement. This is because when the casing string is in an unexpanded state, an outer surface of the casing string does not contact the surrounding borehole formation (until at least a portion of the casing has been radially expanded), and thus there is no inherent initial anchoring point.

Slips are conventionally used to temporarily anchor the unexpanded casing to the borehole during the expansion process. Slips are generally wedge-shaped, steel, hinged sections which provide a temporary anchor when used. Slips are actuated whereby the wedge-shaped sections engage with the surrounding borehole formation or a casing or liner section.

However, the mechanical configuration of slips often suffers from damage of the casing or liner. In some cases, the damage causes the slip to fail due to a loss of mechanical grip. Slip-type devices in open-hole engaging formation are often prone to slippage also.

According to a first aspect of the present invention, there is provided an apparatus for anchoring a first conduit to a second conduit, the apparatus comprising

string or the like to be passed through the inflatable device in use.

Optionally, the inflatable device includes an expander device. The expander device is optionally telescopically coupled to the inflatable device, so that when the expander device is moved a certain distance, the inflatable device is deflated and subsequently moves with the expander device.

Alternatively, the expandable device may be releasably attached to the inflatable device, typically using a latch mechanism.

The inflatable device may be located within the expandable conduit. Alternatively, the inflatable device may be coupled at or near an upper end of the expandable conduit, or at or near a lower end of the expandable conduit. The inflatable device may be coupled to the expandable conduit using a suitable connection.

The inflatable device is typically inflated to expand the expandable conduit whereby the expandable conduit contacts the second conduit, thereby providing an anchor. In this embodiment, the expandable conduit is optionally provided with a slotted portion to facilitate expansion. This is advantageous as the contact between the expandable conduit and the second conduit provides the anchor, and forces applied to the expandable conduit are mainly channelled into the second conduit via the expandable conduit and not the inflatable device.

Alternatively, the inflatable device is inflated whereby a portion thereof directly contacts the second

the expandable conduit (eg using drill pipe, rods, coiled tubing, a wireline or the like).

Optionally, the inflatable device may act as a seal whereby fluid pressure can be applied below the seal.

Embodiments of the present invention shall now be described, by way of example only, with reference to the accompanying drawings, in which:-

Figs 1a to 1d are successive stages in anchoring and expanding an expandable conduit within a second conduit using a first embodiment of an inflatable device;

Figs 2a to 2d are successive stages in anchoring and expanding an expandable conduit within a borehole to tie back the expandable conduit to a casing using a second embodiment of an inflatable device; and

Figs 3a to 3d are successive stages in anchoring and expanding an expandable conduit within a second conduit using a third embodiment of an inflatable device.

Referring to Fig. 1, there is shown in sequence (Figs 1a to 1d) successive stages of anchoring an expandable conduit 10 to a casing 12 provided in a borehole (not shown), the borehole typically being drilled to facilitate the recovery of hydrocarbons. The expandable conduit 10 is typically an expandable liner, but any type of expandable conduit may be used.

The borehole is conventionally lined with a casing to prevent the formation around the borehole from collapsing and also to prevent unwanted fluids from the surrounding formation from flowing into the borehole, and similarly, prevents fluids from within the borehole

Referring to Fig. 1b, the inflatable device 14 is inflated to expand the inflatable annular balloon-type portion 14b. As the balloon-type portion 14b expands, an anchor portion 10a of the conduit 10 is also expanded. The anchor portion 10a is expanded by the inflatable device 14 until it contacts the casing 12, as shown in Fig. 1b. This contact between the anchor portion 10a of the expandable conduit 10 and casing 12 provides an anchor point and/or a seal between the expandable conduit 10 and the casing 12. The outer surface of the anchor portion 10a may be suitably profiled (eg ribbed) or coated with a friction and/or sealing material to enhance the grip of the conduit 10 on the casing 12.

It should be noted that forces applied to the conduit 10, eg by subsequent movement of the conduit 10, that is by pushing or pulling on the conduit 10 for example, will be mainly transferred to the casing 12 via the anchor point and not through the inflatable device 14. This is advantageous as it reduces the risk of damage to the inflatable device 14. Additionally, this also reduces the risk of damage to the casing 12 which may have occurred where a conventional slip was used. Also, conventional slips may lose their grip on the casing 12 where damage ensues or the casing 12 is weak. Transferring substantially all of the forces directly to the casing 12 via the anchor point obviates these disadvantages.

The expander device 16 can then be pulled through the expandable conduit 10 to radially expand the conduit 10, as shown in Fig. 1c. The expander device 16 can be propelled through the conduit 10 in any conventional manner. In Fig. 1, the expander device 16 is pulled through the conduit 10 using a drill pipe 20 which is

surrounding formation and no rig is required. With the inflatable device 14 configured as an annular ring 14r, substantially full bore access is still possible.

It should be noted that the method described with reference to Fig. 1 is intended to expand the expandable conduit 10 in a single pass of the expander device 16 through the expandable conduit 10, but multiple passes and/or expansions are possible.

Referring to Fig. 2, there is shown in sequence (Figs 2a to 2d) successive stages of hanging an expandable conduit 30 off a casing 32 (ie tying back a liner), the expandable conduit 30 typically comprising an expandable liner and being used to line or case a lower portion of a borehole 34, the borehole 34 typically being drilled to facilitate the recovery of hydrocarbons. The lower portion of the borehole 34 has not been lined/cased, wherein the upper portion of the borehole 34 has been lined with an existing casing or liner 36.

In the embodiment shown in Fig. 2, the expandable conduit 30 is provided with a friction and/or sealing material 38 on an outer surface thereof. The function of the friction and/or sealing material 38 is to provide a (friction and/or sealing) coupling between the expandable conduit 30 and the existing liner or casing 36. The friction and/or sealing material 38 may also provide a seal between the lower (unlined) and upper (lined) portions of the borehole 34.

Referring to Fig. 2, an inflatable device 40, which has an expander device 42 releasably attached thereto, is positioned within the expandable conduit 30 before the conduit 30 is inserted into the borehole 34. The

inflated to expand the inflatable annular balloon-type portion 40b. As the balloon-type portion 40b expands, the expandable portion 44 also expands. As can be seen in Fig. 2b, the longitudinal slots 48 widen as the portion 44 expands. Portion 44 acts as an anchor for the casing 30 and is expanded until it contacts the borehole 34, as shown in Fig. 2b. This contact between portion 44 and the borehole 34 provides an anchor point and/or a seal between the expandable conduit 30 (to which portion 44 is releasably attached) and the borehole 34.

As with the previous embodiment, the expander device 42 is then pulled through the expandable conduit 30 to radially expand the conduit 30, as shown in Fig. 2c. The expander device 42 can be propelled through the conduit 30 in any conventional manner. In Fig. 2, the expander device 42 is pulled through the conduit 30 using a drill pipe 52 which is attached to the expander device 42 in any conventional manner.

As the expander device 42 is pulled upwards, the upward movement thereof is stopped after a predetermined time or distance, at which point the expander device 42 is lowered until a coupling between the expander device 42 and the inflatable device 40 latches. As with the previous embodiments, the inflatable annular balloon-type portion 40b is automatically deflated and further upward movement of the expander device 42 causes the inflatable device 40 also to move upward, as shown in Fig. 2d. It should be noted that the upward movement of the expander device 42 should only be stopped once a sufficient length of conduit 30 has been expanded to provide a sufficient anchor.

It should also be noted that the portion 44 is no

An inflatable device 84 is releasably attached to a lower end 801 of the expandable conduit 80 before the conduit 80 is inserted into the casing 82. The expander device 86 is located within the lower end 801 of the conduit 80, the lower end 801 being expanded to accommodate the expander device 86. Similar to the previous embodiment, the inflatable device 84 has the expander device 86 releasably coupled thereto via a coupling 88. Otherwise, the inflatable device 84 and the expander device 86 are substantially the same as the previous embodiments.

Referring to Fig. 3a, the casing 80 with the inflatable device 84 attached thereto and the expander device 86 located therein is run into the hole to the required setting depth. It will be appreciated that although Figs 3a to 3d show the inflatable device 84 releasably attached to the lower end 801 of the conduit 80, the inflatable device 84 may be releasably attached at, or near, an upper end of the conduit 80.

The inflatable device 84 may be of any suitable configuration, but is typically a device which has an inflatable annular balloon-type portion 84b which is mounted on an annular ring 84r. The annular ring 84r allows a string, wireline or the like to be passed through the inflatable device 84 as required. This is particularly advantageous where the inflatable device 84 and/or the expander device 86 are positioned at the upper end of the conduit 80.

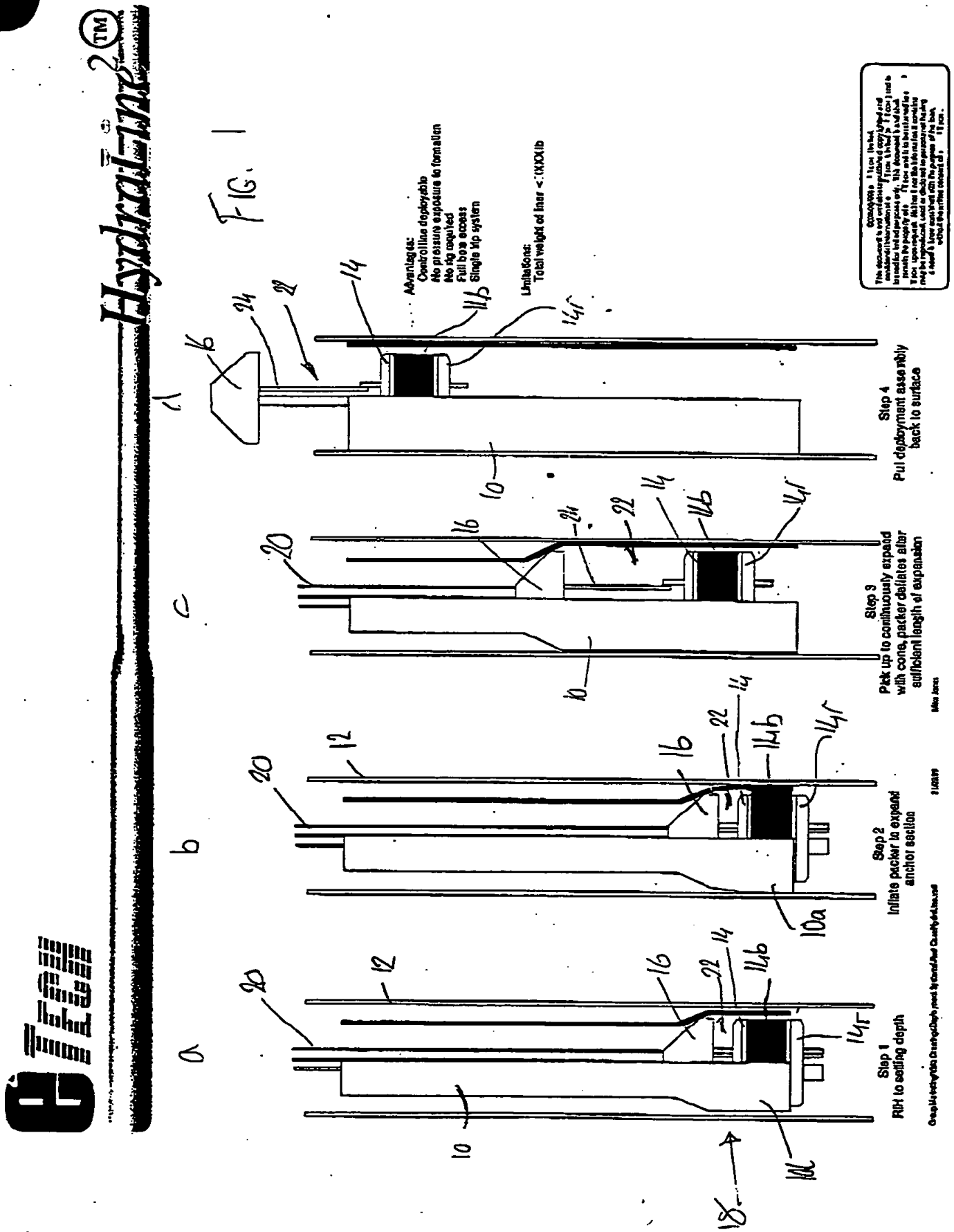
Referring to Fig. 3b, the inflatable device 84 is inflated to expand the inflatable annular balloon-type portion 84b. As the balloon-type portion 84b expands, it contacts the casing 82, thus providing an anchor between the conduit 80 and the casing 82. This contact

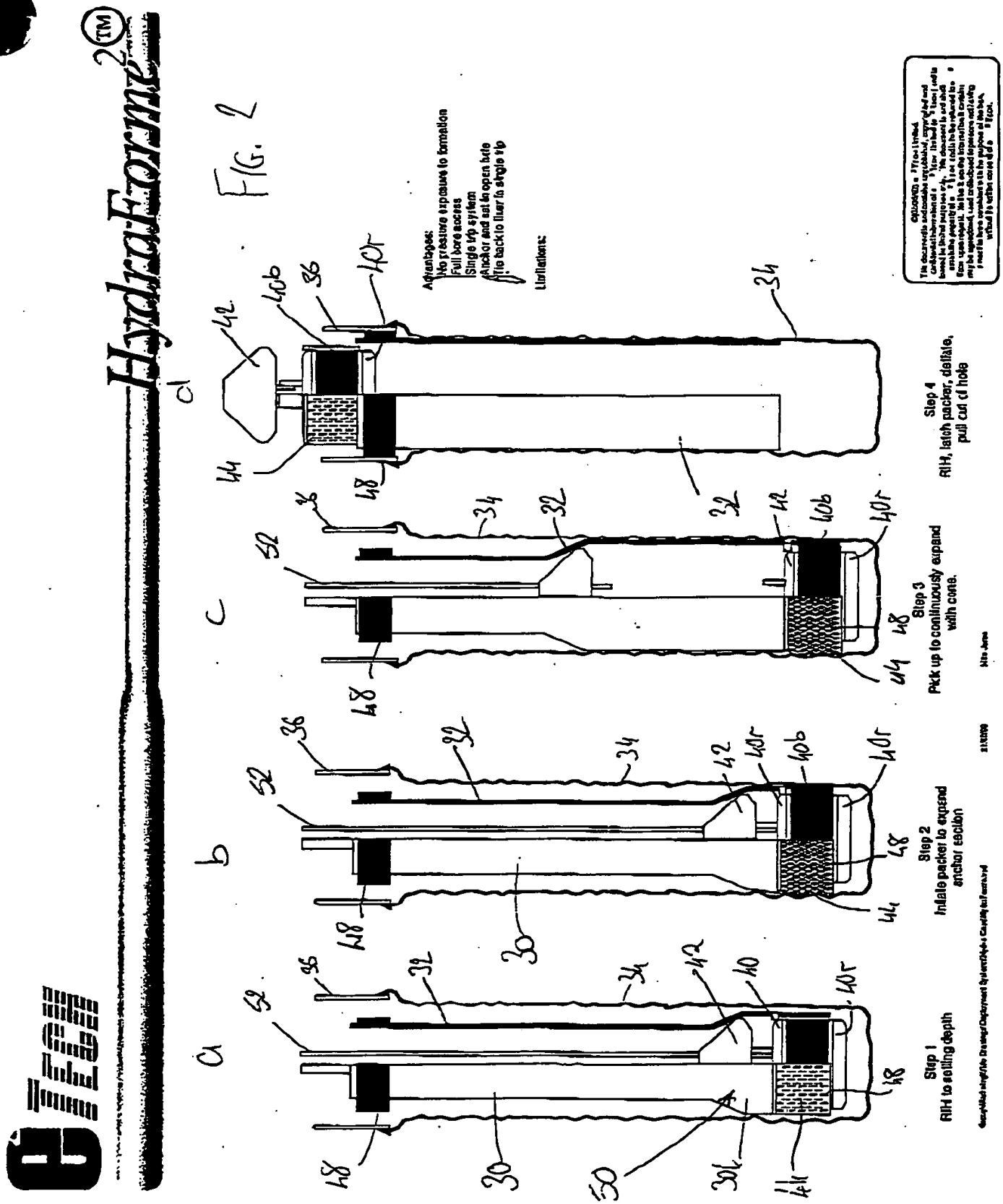
The expander device 86 is continually pulled upwards towards the surface until the conduit 80 is fully expanded to contact the casing 82. Thereafter, the inflatable device 84 and the expander device 86 may be removed from the borehole at the surface.

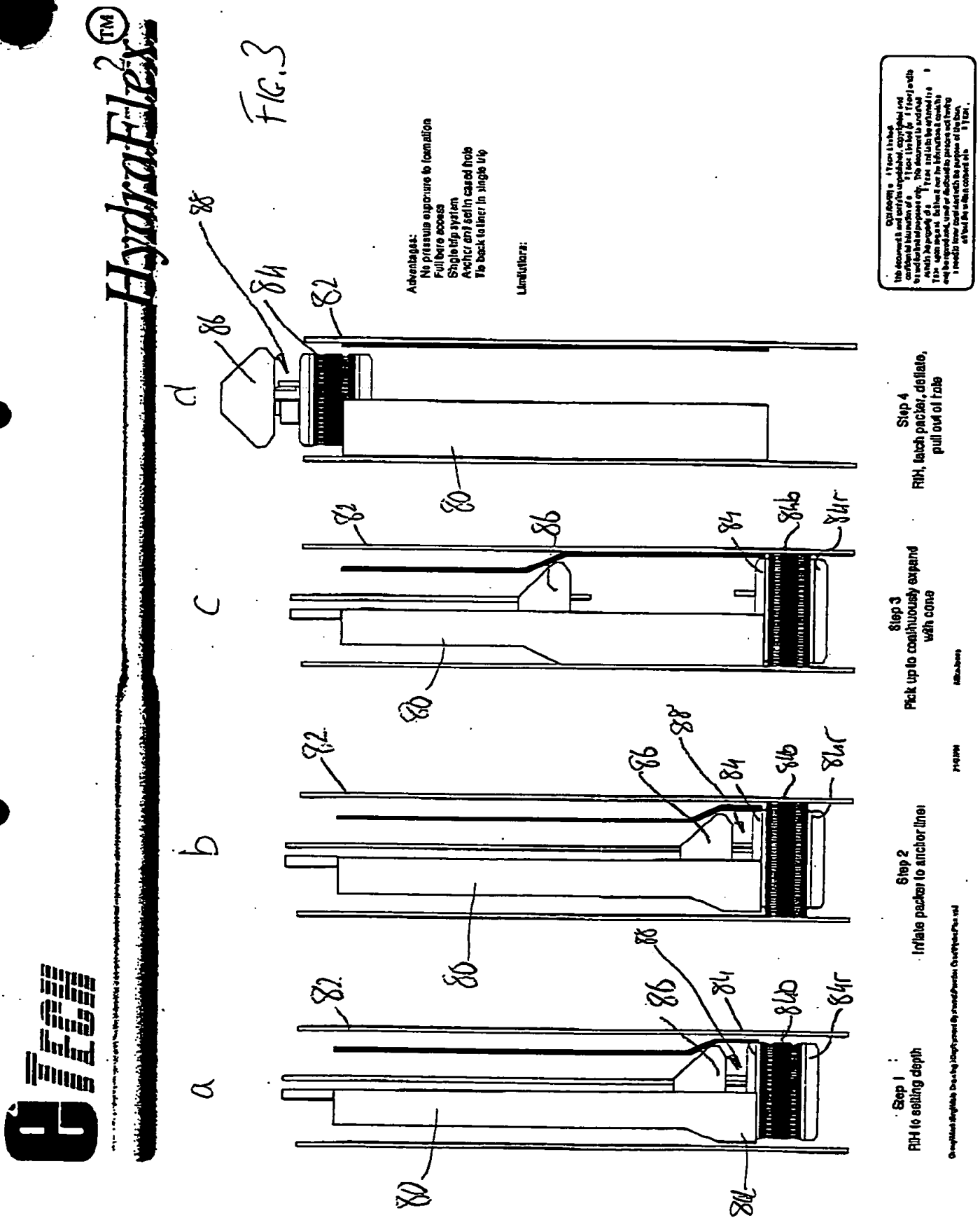
Anchoring and expanding the conduit 80 in this way has the same advantages as in the previous embodiments.

The method and apparatus described herein may be used for a plurality of different downhole functions relating to the use of expandable conduit. For example, they may be used where the original liner or casing requires to be repaired due to damage or the like by overlaying the damaged portion with a portion of expandable conduit. They may also be used to tie back to the liner or casing, as described herein.

Thus, there is provided in certain embodiments an apparatus and method of anchoring an expandable conduit to a second conduit. The apparatus and method of certain embodiments provide numerous advantages over conventional mechanical anchoring devices, such as slips, particularly by reducing the potential damage to conduits which slips may cause. Certain embodiments of apparatus and methods involve the use of an inflatable device which can either be a) attached directly at, or near, the top or bottom of the expandable conduit, or b) placed within the top or bottom of the expandable conduit. In a), anchoring forces are generated as a result of friction between the inflatable device and the second conduit, the forces being passed into the conduit via the inflatable device. In b), anchoring forces are generated by friction between an outer surface of the expandable conduit and the second conduit, the forces being substantially passed into the


Hydraulic Anchor 2 TM
FIG. 1
Advantages:
Controllable deployable
No pressure exposure to formation
No rig required
Full bore access
Single trip system
Limitations:
Total weight of liner < 1(XX)lb
Step 4
Pul deployment assembly back to surface
Step 3
Pick up to continuously expand with cone, packer deflates after sufficient length of expansion
Step 2
Inflate packer to expand anchor section
Step 1
RIH to setting depth
a
b
c
10
10a
12
14
14a
14b
16
18
20
22
24


HydraForm 2 TM
FIG. 2
Advantages:
No pressure exposure to formation
Full bore access
Single trip system
Anchor and set in open hole
Tie back to liner in single trip
Limitations:
Step 1
RIH to setting depth
Step 2
Inflate packer to expand anchor section
Step 3
Pick up to continuously expand with cone.
Step 4
RIH, latch packer, deflate, pull out of hole


HydraEle2x™
Fig. 3
Advantages:
No pressure exposure to formation
Full bore access
Single trip system
Anchor and set in cased hole
Tie back to liner in single trip
Limitations:
Step 1
RIH to setting depth
Step 2
Inflate packer to anchor line
Step 3
Pick up to continuously expand with cone
Step 4
RIH, latch packer, deflate, pull out of hole
a
b
c
d
82
84
86
88
90
92
94
96
98